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# Investigations on Local Seismic Phases and Evaluation of Body Waves Magnitude

Stephane Gaffet
Bernard Massinon
Pierre Mechler
Florence Riviere

Radiomana Societe Civile
27 Rue Claude Bernard
75005 Paris, France

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AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
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"This technical report has been reviewed and is approved for publication"

JAMES F. LEWKOWICZ
Contract Manager
Solid Earth Geophysics Branch
Earth Sciences Division

James C. Battis
JAMES C. BATTIS
Acting Chief
Solid Earth Geophysics Branch
Earth Sciences Division

FOR THE COMMANDER

Donald H. Eckhardt
DONALD H. ECKHARDT, Director
Earth Sciences Division

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)


The scientific work done by RADIOMANA under DARPA Grant nr. AFOSR 87-0331 deals mostly with source studies.

For near events, we computed synthetics seismograms, using BOUCHON's method, for various heterogeneous structures. We put a special emphasis on topographic irregularities. This work was presented in the poster session at the 10th annual DARPA/AFGL SEISMIC RESEARCH SYMPOSIUM (2-5 may 1988). The programs used for this work are now implemented on our new SUN 3/280 system.

For teleseisms, our main effort was first to obtain attenuation models between Eastern Kazakh and several regions in France. The application of these results to source functions for a series of events recorded in France is currently being done. A first by-product from this study was a re-evaluation of the magnitude of all events and a determination of stations corrections.


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| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>James Lewkowicz | 22b. TELEPHONE (Include Area Code)<br>(617) 377-3028 | 22c. OFFICE SYMBOL<br>AFGL/LWH |

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A) STUDIES IN PROGRESS

I) Poster

This study has been presented in the poster session at 10th Annual DARPA/AFGL SEISMIC RESEARCH (2-5 May 1988).

The effects of two-dimensional irregular structures in the vicinity of an explosive line source have been studied at short distances (less than 10 kilometers). The structures are made of a basin or of a ridge. Synthetic seismograms have been computed using the Discrete Wavenumber-Boundary integral equation method (Bouchon, M. and K. Aki - 1977, Bouchon, M., M. Campillo, and S. Gaffet - 1988, Gaffet S. and M. Bouchon - 1988). This seismic wave field representation is as precise as desired for all frequency ranges and type of structure studied.

The location of the source has a great importance on the shape of the seismic field diffracted by the nearby structure. Figure 1 shows surface waves generated by an irregular topography. The source is an explosive source made of two dipoles orthogonal to each other and is located under the ridge, at the basis and inside the ridge. The most important effect is an increasing of the amplitude of the diffracted Rayleigh wave when the source is located inside the ridge (See Figure 1c compare to Figure 1a and 1b). Figure 2 shows the effects of the position of an explosive source placed inside a basis. Three locations have been studied, (i) source located in the thin part of the basis (ii) source located between the thin and the thick parts of the basis (iii) source located straight above the thick part of the basis. The most important observed effect is the generation of a relatively higher frequency diffracted wave field when the source is located in the thick part of the basis (See Figure 2c and compare to Figure 2a). This effect had been experimentally showed by Vassiliou et al. (1987), for a source acting at the surface of a Yucca-type basis.

II) Present study

We are now considering the reciprocity principal at local distances and will extend it at teleseismic distances to study the importance of the source structure response in the determination of the energy of seismic or artificial event.

III) Other developments

An other part of the work had been the development of graphic software on the SUN-2 work station. This software permits graphics program written with a BENSON language to run. This software uses the SUN-CORE library to plot graphics on the screen and writes a POSTSCRIPT program which finally will be used to produce hard copy with the maximum resolution of the Appler Laser Writer.

B) SUN SYSTEM

We have received a SUN system configuration (One SUN 3/280 and two SUN 3/50 in Ethernet) at the beginning of July.

We are installing the "mgp" programs which was previously adapted to our seismic network for a SUN 2/170 configuration. These programs are able to:

- Make possible the acquisition of seismic data recorded on digital magnetic tapes (1600 bpi) which are composed of S.P. and L.P. signals from the French seismic network (30 S.P. stations and 6 L.P. 3 components stations).

- Demultiplex the channels

- Display on the screen selected channels or the whole set of channels

- Apply on them processing modules (filtering, correlations, spectra, delay and sum, etc)

- These first developments should be over at the beginning of October 1988.

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Vassiliou, M.S., M. Abdel-Gawad, and B.R. Tittmann (1987)
Ultrasonic physical modeling of seismic wave propagation from graben-like structures
AFGL-TR-87-0256, pp 1-29 (ADA189066)

## Figure captions:

Figure 1: The geometry of the topography profile is displayed with the locations of the receivers and sources. The left hand side of the figures 1a, 1b, and 1c represents the horizontal (U) and vertical (W) ground displacement. The right hand side shows the polarization plot which corresponds to a time extension of the particule motions.

Figure 2: The geometry of the structure is displayed in the left center of the figure with the locations of the receivers (1 through 31) and the three positions of the explosions (A,B, and C). The three other diagrams represent a time-space representation of the ground displacement.

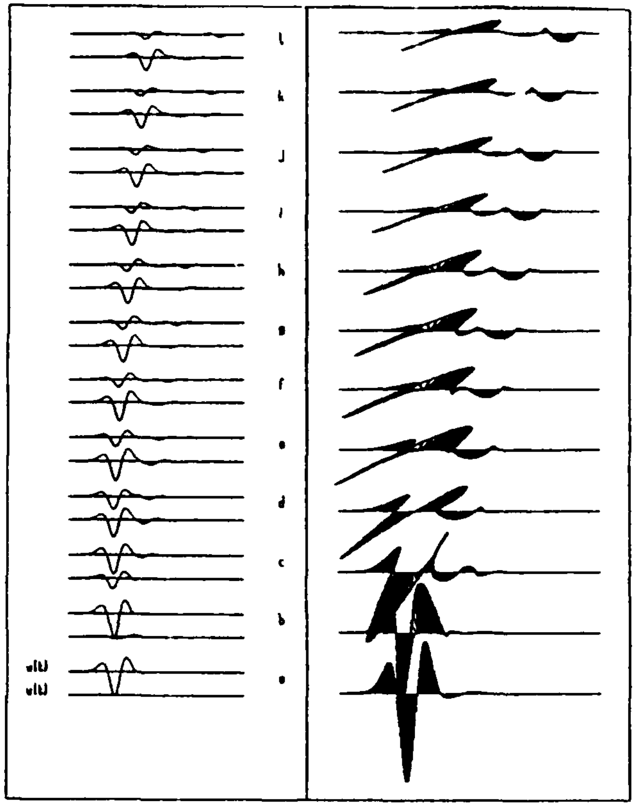
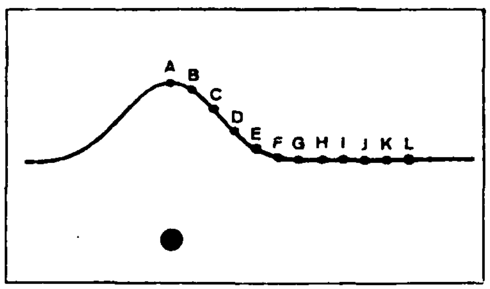



FIGURE 1A



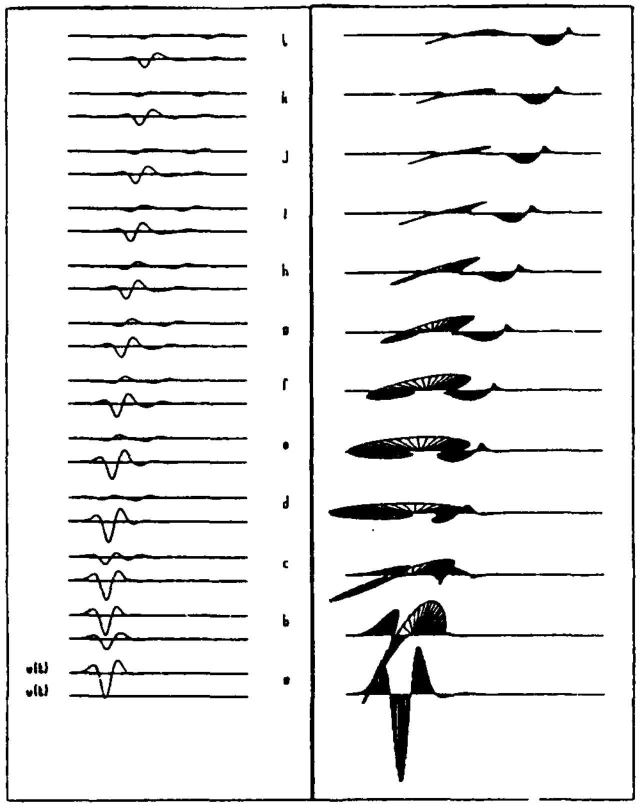
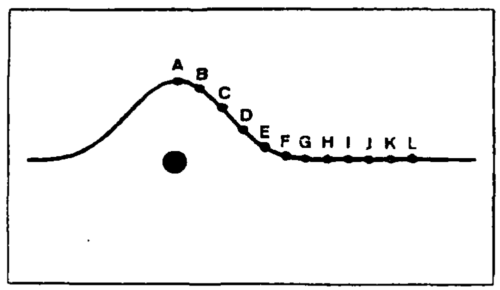




FIGURE 1B



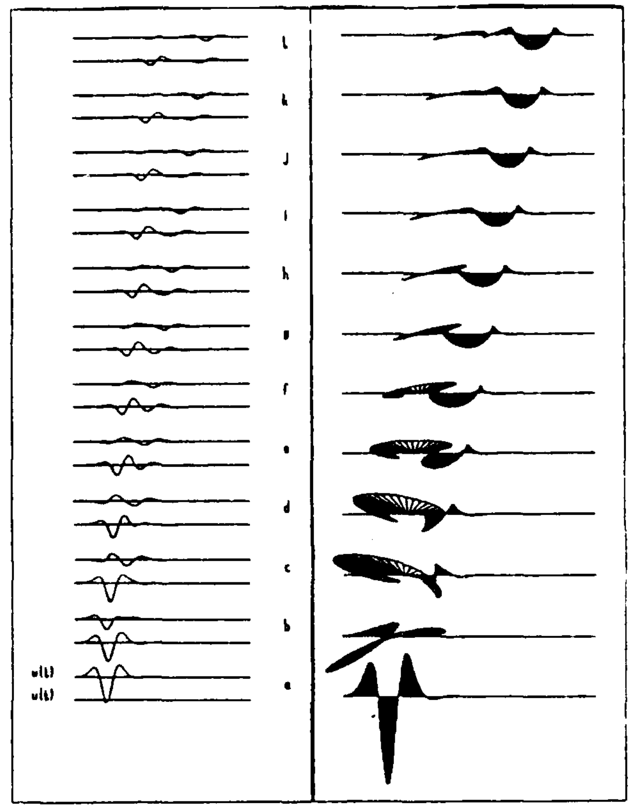




FIGURE 1C

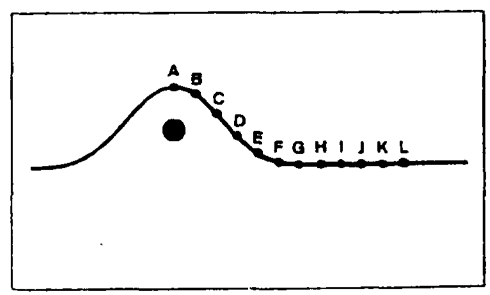


FIGURE 2A

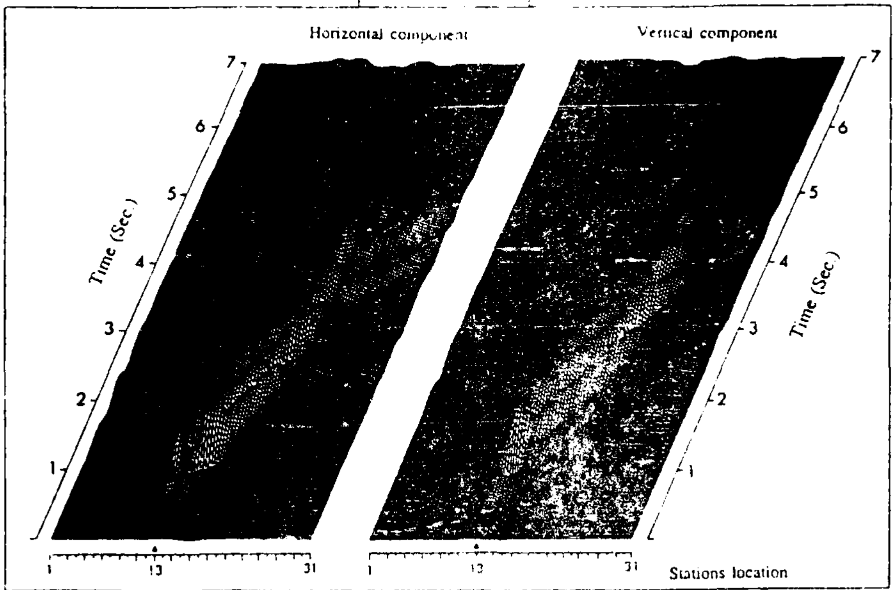



FIGURE 2B

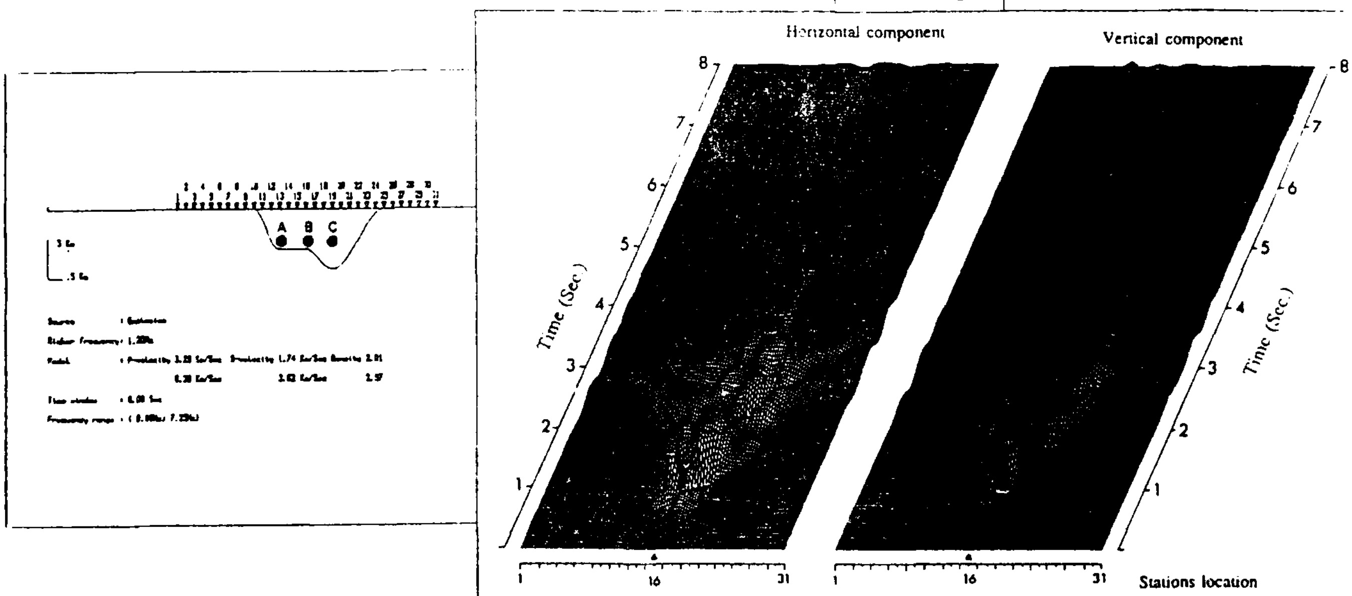
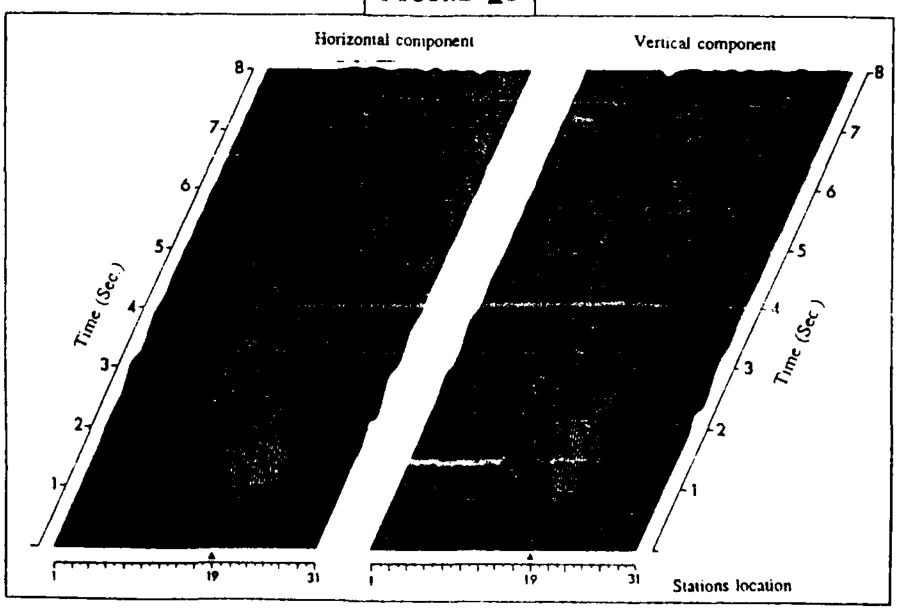



FIGURE 2C



## C) STUDY OF TELESEISM FROM EASTERN KAZAKH

### 1) *Magnitude estimation*

We studied a set of events originating in Eastern Kazakh, all with very similar source functions and recorded by the French Seimic Network. An averaged (weighted) signal was computed from the 27 stations of the network and defines the *averaged event* recorded in France.

For each station *s* and each event *e*, the signal $X_s^e$ is represented as :

$$X_s^e = K_s^e \,\overline{X} + \text{noise}$$

but also

$$X^e = K^e \,\overline{X} + \text{noise}$$

$X^e$ being the averaged (weighted) signal in France for the event *e*.

The $K^e$ and $K_s^e$ factors have to be a function of magnitude :

$$m_b = \mathbf{a} \log(K) + \mathbf{b}$$

We compute **a** and **b** from the magnitudes defined by the classical way. The expected value for **a** is 1. , **b** is a scaling factor including epicentral distance and station's corrections.

**a** coefficient determination allowed us to point out important variations of the value depending on the studied station. The comparison was made with several determination of magnitude, including the magnitude published by the French Seimic Network and by ISC. **a** coefficients computed from those various data give the same *anomalies*.

The origin of **a** value variations is certainly related to the spectral content of the signals. The band pass of the used seismometer has an influence on the measure of $\log\left(\frac{A}{T}\right)$, it is also not obvious that the ratio of two $\log\left(\frac{A}{T}\right)$ from 2 events remains constant with distance, even measured by similar seismometers.

The conclusion of our study is that the magnitudes computed from K factors seem more precise than those obtained in the classical way because of their independence from the instrumental response. But the mean disadvantage is that this method could only be applied for the comparison of events with very close sources.

## 2) *Source functions*

We tried to obtain the studied event characteristics: yield **W** and depth of burial **h**. All the events originating in the same region, we'll tried to define a relation like:

$$h = c\ \mathbf{W}^d$$

as Mueller and Murphy did for NTS events.

### a) *Attenuation modeling*

In order to obtain source function spectra we had to define attenuation models. The followed method is decribed by T. Bache and al. (1986). The french array is too wide with regard to the arrays used by T. Bache so we defined 6 subarrays by using geological features.
We determined 6 attenuation models from a mean spectrum computed for each subarray. The figure 1 shows how we fitted the spectra with the theorical models. The results obtained for the region 5 surely are in relation with the very complicated structure of this region.
The obtained parameters are presented in the following table:

| reg | $t_0$ | $\tau_m$ | $t_1$ |
|---|---|---|---|
| 1 | 0.55 | 0.04 | |
| 2 | 0.75 | 0.05 | 0.02 |
| 3 | 0.80 | 0.05 | |
| 4 | 0.75 | 0.05 | |
| 5 | 0.75 | 0.05 | 0.04 |
| 6 | 0.75 | 0.05 | |

### b) *Source function parameters modeling*

We used the Mueller-Murphy model (1971) for the source function spectrum modeling. We used an inversion method by least-squares fit to define the parameters **h** and **W**. The relation to minimize is:

$$f_o\ (\omega) = f_t\ (\omega) + \Delta h\ \frac{\delta f_t\ (\omega)}{\delta h} + \Delta W\ \frac{\delta f_t\ (\omega)}{\delta W}$$

where $f_o$ is the observed spectrum and $f_t$ the theorical spectrum. $\Delta h$ and $\Delta W$ are the parameters which added respectively to **h** et W allow to find the "true" values for h and W by iteration.
This method didn't provide good results because the theorical curves of the source function spectra are really characteristic between 0.5 and 2 Hz, frequency range where we find the frequency corner. But the usual band recorded by the network is between 1 and 15 Hz (flat in velocity for a 1 Hz seismometer).

### c) *Low frequency spectra contents improvement*

Our present work is devoted to the re-processing of our data after an extension of the spectral contents from 1 Hz to 0.25 Hz.
After extension of the band width, we'll try to follow the same method than described previously to obtain the source function parameters.

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Bull. Seism. Soc. Am., 65, 1675-1692.

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Geophys. J.R. astr. Soc., 31, 83-97.

Figure captions:

Figure 1: Attenuation models for the 6 regions of France.
region 1: Armorican massif
region 2: Central massif
region 3: Aquitain bassin
region 4: South east of France
region 5: Morvan (North of Central massif)
region 6: Vosges (East of France)

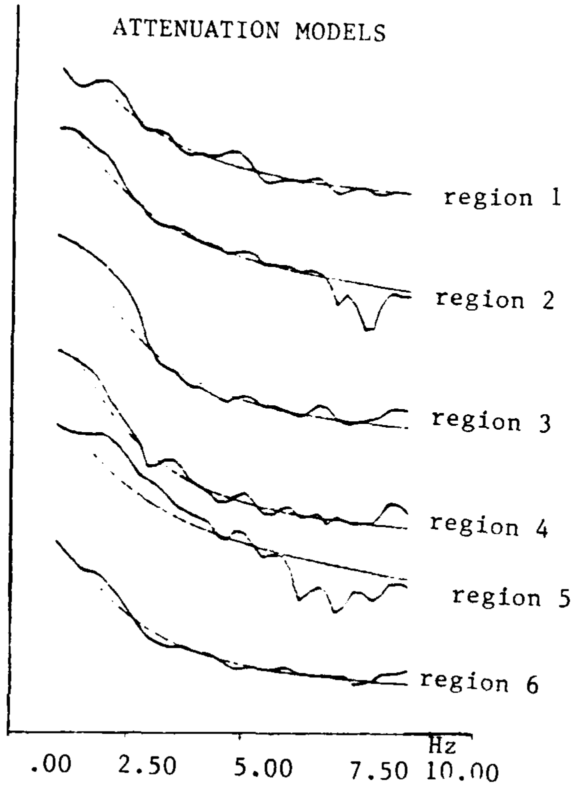
ATTENUATION MODELS
region 1
region 2
region 3
region 4
region 5
region 6
Hz
.00
2.50
5.00
7.50
10.00

FIGURE 1

CONTRACTORS (United States)

Professor Keiiti Aki
Center for Earth Sciences
University of Southern California
University Park
Los Angeles, CA 90089-0741

Professor Charles B. Archambeau
Cooperative Institute for Resch
in Environmental Sciences
University of Colorado
Boulder, CO 80309

Dr. Thomas C. Bache Jr.
Science Applications Int'l Corp.
10210 Campus Point Drive
San Diego, CA 92121 (2 copies)

Dr. Douglas R. Baumgardt
Signal Analysis & Systems Div.
ENSCO, Inc.
5400 Port Royal Road
Springfield, VA 22151-2388

Dr. Jonathan Berger
Institute of Geophysics and
Planetary Physics
Scripps Institution of Oceanography
A-025
University of California, San Diego
La Jolla, CA 92093

Dr. S. Bratt
Science Applications Int'l Corp.
10210 Campus Point Drive
San Diego, CA 92121

Dr. Lawrence J. Burdick
Woodward-Clyde Consultants
P.O. Box 93245
Pasadena, CA 91109-3245 (2 copies)

Professor Robert W. Clayton
Seismological Laboratory/Div. of
Geological & Planetary Sciences
California Institute of Technology
Pasadena, CA 91125

Dr Karl Coyner
N. E. Research
P.O. Box 857
Norwich, VT 05055

Dr. Vernon F. Cormier
Department of Geology & Geophysics
U-45, Room 207
The University of Conneticut
Storrs, Connecticut 06268

Dr. Steven Day
Dept. of Geological Sciences
San Diego State U.
San Diego, CA 92182

Dr. Zoltan A. Der
ENSCO, Inc.
5400 Port Royal Road
Springfield, VA 22151-2388

Professor John Ferguson
Center for Lithospheric Studies
The University of Texas at Dallas
P.O. Box 830688
Richardson, TX 75083-0688

Professor Stanley Flatte'
Applied Sciences Building
University of California,
Santa Cruz, CA 95064

Dr. Alexander Florence
SRI International
333 Ravenswood Avenue
Menlo Park, CA 94025-3493

Professor Steven Grand
Department of Geology
245 Natural History Building
1301 West Green Street
Urbana, IL 61801

Dr. Henry L. Gray
Associate Dean of Dedman College
Department of Statistical Sciences
Southern Methodist University
Dallas, TX 75275

Professor Roy Greenfield
Geosciences Department
403 Deike Building
The Pennsylvania State University
University Park, PA 16802

Professor David G. Harkrider
Seismological Laboratory
Div of Geological & Planetary Sciences
California Institute of Technology
Pasadena, CA 91125

Professor Donald V. Helmberger
Seismological Laboratory
Div of Geological & Planetary Sciences
California Institute of Technology
Pasadena, CA 91125

Professor Eugene Herrin
Institute for the Study of Earth
and Man/Geophysical Laboratory
Southern Methodist University
Dallas, TX 75275

Professor Robert B. Herrmann
Department of Earth & Atmospheric
Sciences
Saint Louis University
Saint Louis, MO 63156

Professor Bryan Isacks
Cornell University
Dept of Geological Sciences
SNEE Hall
Ithaca, NY 14850

Professor Lane R. Johnson
Seismographic Station
University of California
Berkeley, CA 94720

Professor Thomas H. Jordan
Department of Earth, Atmospheric
and Planetary Sciences
Mass Institute of Technology
Cambridge, MA 02139

Dr. Alan Kafka
Department of Geology &
Geophysics
Boston College
Chestnut Hill, MA 02167

Professor Leon Knopoff
University of California
Institute of Geophysics
& Planetary Physics
Los Angeles, CA 90024

Professor Charles A. Langston
Geosciences Department
403 Deike Building
The Pennsylvania State University
University Park, PA 16802

Professor Thorne Lay
Department of Geological Sciences
1006 C.C. Little Building
University of Michigan
Ann Arbor, MI 48109-1063

Dr. Randolph Martin III
New England Research, Inc.
P.O. Box 857
Norwich, VT 05055

Dr. Gary McCartor
Mission Research Corp.
735 State Street
P.O. Drawer 719
Santa Barbara, CA 93102 (2 copies)

Professor Thomas V. McEvilly
Seismographic Station
University of California
Berkeley, CA 94720

Dr. Keith L. McLaughlin
S-CUBED,
A Division of Maxwell Laboratory
P.O. Box 1620
La Jolla, CA 92038-1620

Professor William Menke
Lamont-Doherty Geological Observatory
of Columbia University
Palisades, NY 10964

Professor Brian J. Mitchell
Department of Earth & Atmospheric
Sciences
Saint Louis University
Saint Louis, MO 63156

Mr. Jack Murphy
S-CUBED
A Division of Maxwell Laboratory
11800 Sunrise Valley Drive
Suite 1212
Reston, VA 22091 (2 copies)

Professor J. A. Orcutt
Institute of Geophysics and Planetary
Physics, A-205
Scripps Institute of Oceanography
Univ. of California, San Diego
La Jolla, CA 92093

Professor Keith Priestley
University of Nevada
Mackay School of Mines
Reno, NV 89557

Professor Paul G. Richards
Lamont-Doherty Geological
Observatory of Columbia Univ.
Palisades, NY 10964

Wilmer Rivers
Teledyne Geotech
314 Montgomery Street
Alexandria, VA 22314

Dr. Alan S. Ryall, Jr.
Center of Seismic Studies
1300 North 17th Street
Suite 1450
Arlington, VA 22209-2308 (4 copies)

Professor Charles G. Sammis
Center for Earth Sciences
University of Southern California
University Park
Los Angeles, CA 90089-0741

Professor Christopher H. Scholz
Geological Sciences
Lamont-Doherty Geological Observatory
Palisades, NY 10964

Dr. Jeffrey L. Stevens
S-CUBED,
A Division of Maxwell Laboratory
P.O. Box 1620
La Jolla, CA 92038-1620

Professor Brian Stump
Institute for the Study of Earth & Man
Geophysical Laboratory
Southern Methodist University
Dallas, TX 75275

Professor Ta-liang Teng
Center for Earth Sciences
University of Southern California
University Park
Los Angeles, CA 90089-0741

Dr. Clifford Thurber
State University of New York at
Stony Brooks
Dept of Earth and Space Sciences
Stony Brook, NY 11794-2100

Professor M. Nafi Toksoz
Earth Resources Lab
Dept of Earth, Atmospheric and
Planetary Sciences
Massachusetts Institute of Technology
42 Carleton Street
Cambridge, MA 02142

Professor Terry C. Wallace
Department of Geosciences
Building #11
University of Arizona
Tucson, AZ 85721

Weidlinger Associates
ATTN: Dr. Gregory Wojcik
4410 El Camino Real, Suite 110
Los Altos, CA 94022

Professor Francis T. Wu
Department of Geological Sciences
State University of New York
at Binghamton
Vestal, NY 13901

OTHERS (United States)

Dr. Monem Abdel-Gawad
Rockwell Internat'l Science Center
1049 Camino Dos Rios
Thousand Oaks, CA 91360

Professor Shelton S. Alexander
Geosciences Department
403 Deike Building
The Pennsylvania State University
University Park, PA 16802

Dr. Ralph Archuleta
Department of Geological
Sciences
Univ. of California at
Santa Barbara
Santa Barbara, CA

Dr. Muawia Barazangi
Geological Sciences
Cornell University
Ithaca, NY 14853

J. Barker
Department of Geological Sciences
State University of New York
at Binghamton
Vestal, NY 13901

Mr. William J. Best
907 Westwood Drive
Vienna, VA 22180

Dr. N. Biswas
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

Dr. G. A. Bollinger
Department of Geological Sciences
Virginia Polytechnical Institute
21044 Derring Hall
Blacksburg, VA 24061

Dr. James Bulau
Rockwell Int'l Science Center
1049 Camino Dos Rios
P.O. Box 1085
Thousand Oaks, CA 91360

Mr. Roy Burger
1221 Serry Rd.
Schenectady, NY 12309

Dr. Robert Burridge
Schlumberger-Doll Resch Ctr.
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Professor Jon F. Claerbout
Professor Amos Nur
Dept. of Geophysics
Stanford University
Stanford, CA 94305 (2 copies)

Dr. Anton W. Dainty
AFGL/LWH
Hanscom AFB, MA 01731

Professor Adam Dziewonski
Hoffman Laboratory
Harvard University
20 Oxford St.
Cambridge, MA 02138

Professor John Ebel
Dept of Geology & Geophysics
Boston College
Chestnut Hill, MA 02167

Dr. Donald Forsyth
Dept. of Geological Sciences
Brown University
Providence, RI 02912

Dr. Anthony Gangi
Texas A&M University
Department of Geophysics
College Station, TX 77843

Dr. Freeman Gilbert
Institute of Geophysics &
Planetary Physics
Univ. of California, San Diego
P.O. Box 109
La Jolla, CA 92037

Mr. Edward Giller
Pacific Seirra Research Corp.
1401 Wilson Boulevard
Arlington, VA 22209

Dr. Jeffrey W. Given
Sierra Geophysics
11255 Kirkland Way
Kirkland, WA 98033

Rong Song Jih
Teledyne Geotech
314 Montgomery Street
Alexandria, Virginia 22314

Professor F.K. Lamb
University of Illinois at
Urbana-Champaign
Department of Physics
1110 West Green Street
Urbana, IL 61801

Dr. Arthur Lerner-Lam
Lamont-Doherty Geological Observatory
of Columbia University
Palisades, NY 10964

Dr. L. Timothy Long
School of Geophysical Sciences
Georgia Institute of Technology
Atlanta, GA 30332

Dr. Peter Malin
University of California at Santa Barbara
Institute for Central Studies
Santa Barbara, CA 93106

Dr. George R. Mellman
Sierra Geophysics
11255 Kirkland Way
Kirkland, WA 98033

Dr. Bernard Minster
Institute of Geophysics and Planetary
Physics, A-205
Scripps Institute of Oceanography
Univ. of California, San Diego
La Jolla, CA 92093

Professor John Nabelek
College of Oceanography
Oregon State University
Corvallis, OR 97331

Dr. Geza Nagy
U. California, San Diego
Dept of Ames, M.S. B-010
La Jolla, CA 92093

Dr. Jack Oliver
Department of Geology
Cornell University
Ithaca, NY 14850

Dr. Robert Phinney/Dr. F.A. Dahlen
Dept of Geological
Geophysical Sci. University
Princeton University
Princeton, NJ 08540 (2 copies)

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Attn: Dr. Jay Pulli
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Dr. Norton Rimer
S-CUBED
A Division of Maxwell Laboratory
P.O. 1620
La Jolla, CA 92038-1620

Professor Larry J. Ruff
Department of Geological Sciences
1006 C.C. Little Building
University of Michigan
Ann Arbor, MI 48109-1063

Dr. Richard Sailor
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Dr. David G. Simpson
Lamont-Doherty Geological Observ.
of Columbia University
Palisades, NY 10964

Dr. Bob Smith
Department of Geophysics
University of Utah
1400 East 2nd South
Salt Lake City, UT 84112

Dr. S. W. Smith
Geophysics Program
University of Washington
Seattle, WA 98195

Dr. Stewart Smith
IRIS Inc.
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Dr. L. Sykes
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Columbia University
Palisades, NY 10964

Dr. Pradeep Talwani
Department of Geological Sciences
University of South Carolina
Columbia, SC 29208

Dr. R. B. Tittmann
Rockwell International Science Center
1049 Camino Dos Rios
P.O. Box 1085
Thousand Oaks, CA 91360

Professor John H. Woodhouse
Hoffman Laboratory
Harvard University
20 Oxford St.
Cambridge, MA 02138

Dr. Gregory B. Young
ENSCO, Inc.
5400 Port Royal Road
Springfield, VA 22151-2388

OTHERS (FOREIGN)

Dr. Peter Basham
Earth Physics Branch
Geological Survey of Canada
1 Observatory Crescent
Ottawa, Ontario
CANADA  K1A OY3

Dr. Eduard Berg
Institute of Geophysics
University of Hawaii
Honolulu, HI  96822

Dr. Michel Bouchon - Universite
  Scientifique et Medicale de Grenob
Lab de Geophysique - Interne et
  Tectonophysique - I.R.I.G.M-B.P.
38402 St. Martin D'Heres
Cedex FRANCE

Dr. Hilmar Bungum/NTNF/NORSAR
P.O. Box 51
Norwegian Council of Science,
Industry and Research, NORSAR
N-2007 Kjeller, NORWAY

Dr. Michel Campillo
I.R.I.G.M.-B.P. 68
38402 St. Martin D'Heres
Cedex, FRANCE

Dr. Kin-Yip Chun
Geophysics Division
Physics Department
University of Toronto
Ontario, CANADA M5S 1A7

Dr. Alan Douglas
Ministry of Defense
Blacknest, Brimpton,
 Reading RG7-4RS
UNITED KINGDOM

Dr. Manfred Henger
Fed. Inst. For Geosciences & Nat'l Res.
Postfach 510153
D-3000 Hannover 51
FEDERAL REPUBLIC OF GERMANY

Dr. E. Husebye
NTNF/NORSAR
P.O. Box 51
N-2007 Kjeller, NORWAY

Ms. Eva Johannisson
Senior Research Officer
National Defense Research Inst.
P.O. Box 27322
S-102 54 Stockholm
SWEDEN

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Dr. Robert North
Geophysics Division
Geological Survey of Canada
1 Observatory crescent
Ottawa, Ontario
CANADA, K1A OY3

Dr. Frode Ringdal
NTNF/NORSAR
P.O. Box 51
N-2007 Kjeller, NORWAY

Dr. Jorg Schlittenhardt
Federal Inst. for Geosciences & Nat'l Res.
Postfach 510153
D-3000 Hannover 51
FEDERAL REPUBLIC OF GERMANY

University of Hawaii
Institute of Geophysics
ATTN: Dr. Daniel Walker
Honolulu, HI  96822

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APO Miami, Florida 34032

Professor Peter Harjes
Institute for Geophysik
Rhur University/Bochum
P.O. Box 102148, 4630 Bochum 1
FEDERAL REPUBLIC OF GERMANY

Professor Brian L.N. Kennett
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Institute of Advanced Studies
G.P.O. Box 4
Canberra 2601
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Societe Radiomana
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75005, Paris, FRANCE

GOVERNMENT

Dr. Ralph Alewine III
DARPA/NMRO
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Arlington, VA 22209-2308

Dr. Robert Blandford
DARPA/NMRO
1400 Wilson Boulevard
Arlington, VA 22209-2308

Sandia National Laboratory
ATTN: Dr. H. B. Durham
Albuquerque, NM 87185

Dr. Jack Evernden
USGS-Earthquake Studies
345 Middlefield Road
Menlo Park, CA 94025

U.S. Geological Survey
ATTN: Dr. T. Hanks
Nat'l Earthquake Resch Center
345 Middlefield Road
Menlo Park, CA 94025

Dr. James Hannon
Lawrence Livermore Nat'l Lab.
P.O. Box 808
Livermore, CA 94550

Paul Johnson
ESS-4, Mail Stop J979
Los Alamos National Laboratory
Los Alamos, NM 87545

Ms. Ann Kerr
DARPA/NMRO
1400 Wilson Boulevard
Arlington, VA 22209-2308

Dr. Max Koontz
US Dept of Energy/DP 5
Forrestal Building
1000 Independence Ave.
Washington, D.C. 20585

Dr. W. H. K. Lee
USGS
Office of Earthquakes, Volcanoes,
& Engineering
Branch of Seismology
345 Middlefield Rd
Menlo Park, CA 94025

Dr. William Leith
USGS
Mail Stop 928
Reston, VA 22092

Dr. Richard Lewis
Dir. Earthquake Engineering and
Geophysics
U.S. Army Corps of Engineers
Box 631
Vicksburg, MS 39180

Dr. Robert Masse'
Box 25046, Mail Stop 967
Denver Federal Center
Denver, Colorado 80225

Richard Morrow
ACDA/VI
Room 5741
320 21st Street N.W.
Washington, D.C. 20451

Dr. Keith K. Nakanishi
Lawrence Livermore National Lab
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Dr. Carl Newton
Los Alamos National Lab.
P.O. Box 1663
Mail Stop C335, Group E553
Los Alamos, NM 87545

Dr. Kenneth H. Olsen
Los Alamos Scientific Lab.
Post Office Box 1663
Los Alamos, NM 87545

Howard J. Patton
Lawrence Livermore National
Laboratory
P.O. Box 808, L-205
Livermore, CA 94550

Mr. Chris Paine
Office of Senator Kennedy
SR 315
United States Senate
Washington, D.C. 20510

AFOSR/NP
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Patrick AFB, Florida 32925-6001

Mr. Jack Rachlin
USGS - Geology, Rm 3 C136
Mail Stop 928 National Center
Reston, VA 22092

Robert Reinke
AFWL/NTESG
Kirtland AFB, NM 87117-6008

HQ AFTAC/TGR
Attn: Dr. George H. Rothe
Patrick AFB, Florida 32925-6001

Donald L. Springer
Lawrence Livermore National Laboratory
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Livermore, CA 94550

Dr. Lawrence Turnbull
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